IN APP QUIZ AS A TEACHING TOOL FOR COELIAC DISEASE

Research Document

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Abstract

This document will outline the research that was carried out in preparation for developing part of a mobile application to assist people with Coeliac Disease in adhering to a gluten free lifestyle.

This part of the application will consist of an engaging quiz that incorporates gamification techniques such as badges, points, and leader boards to help patients increase their diet compliance.

This document will cover Coeliac Disease, the technologies that will be used to develop the application, and similar applications that use gamification techniques.

Table of Contents

Contents

Introduction

The purpose of this document is to document the research carried out to develop an in-application quiz for people suffering from Coeliac Disease. This quiz is aimed at educating coeliac sufferers as to what is safe to eat to improve their quality of life. To understand the dietary compliance that a coeliac patient must meet, it is necessary to research Coeliac Disease in-depth.

The project is part of the Erasmus+ program that aims to assist people with Coeliac disease to adhere to a gluten free lifestyle using behaviour change techniques by means of a smartphone app. It is an international and interdisciplinary project involving teams from several European academic and medical backgrounds. As the in-app quiz is part of this project, a set of technologies has already been set. These frontend and backend technologies will be discussed.

Research on existing apps that have functionality similar to what will be developed in this project will be the final part of this document.

Coeliac Disease

Overview

Coeliac Disease is an autoimmune disease that is triggered by gluten that is estimated to affect 1 in 100 people in Europe. The antibodies produced when gluten is ingested attack the micro villi that line the small intestine. If coeliac disease remains undiagnosed and the afflicted person continues to consume gluten, the micro villi die off and can no longer absorb any nutrients (AOECS, 2020). There is no cure for Coeliac Disease, but generally following a strict gluten-free can help manage symptoms.

Symptoms

Gluten can trigger the following symptoms:

- Stomach aches, cramping and bloating.
- Nausea and vomiting.
- Constipation and/or diarrhoea.
- Iron, vitamin B12 or folic acid deficiency.
- Fatigue.
- Hair loss (alopecia).
- Dermatitis herpetiformis.
- Bone and/or joint pain.
- Depression.

Other conditions are also linked with Coeliac Disease and may be caused by it that can be an indicator to get tests done to look for Coeliac Disease:

- Osteoporosis, which causes bones to become weak and brittle.
- Peripheral neuropathy, which causes numbness, tingling, or pain.
- Ataxia, a brain condition which causes balance and coordination problems.
- Recurrent miscarriage, sub-fertility, or infertility in women.
- Developing lymphoma, a type of cancer of the gut, in later life.

Silent Coeliac Disease

In addition to patients who suffer varying symptoms of Coeliac Disease, there is Silent, Coeliac Disease, also known as Asymptomatic Coeliac Disease. These patients do not suffer from any symptoms, but still experience damage to the small intestine. Studies show that even though patients thought they had no symptoms, after going on a strict gluten-free diet they report better health and a reduction in acid reflux, abdominal bloating and distention and flatulence (Celiac.org, 2020). A screening for Coeliac Disease can pick up asymptomatic cases.

Causes

The cause of Coeliac Disease is gluten. Gluten is a family of storage proteins - formally known as prolamins — that are naturally found in certain cereal grains, such as wheat, barley, and rye (Healthline, 2020). Gluten can be found in a variety of whole and processed foods, such as:

- Whole wheat, bran, barley, spelt, rye, couscous, and semolina.

- Most types of bread, pasta, pastries, cakes, breakfast cereals.

- Malt, certain types of sauces, beer, and certain types of wine.

In addition to many foods that inherently contain gluten, commercial food preparation could allow cross contamination from gluten products to gluten-free products.

Gamification

Overview

Gamification is the application of game-based elements and game design techniques in non-game activities. The sudden rise of gamification in the past few years can be traced back to the convergence of several enablers: cheap sensors that allow the tracking of everyday activity, a shift in Web analytics to individuals and their behaviors, and the current cultural momentum of video games (Deterding, 2012). Although gamification is a relatively new in terms outside of gaming in technology, the idea behind it has been around since society began. Gamification is a term used in the technology that describes completing tasks to be rewarded and gain self-efficacy, group identification, and social approval.

Game like elements can be used to educate, entertain, and engage. Some classic game elements are Points, Badges, and Leaderboards (Gamify, 2020):

- Points are used as visual identifiers of progress.

- Badges display achievement.

- Leaderboards are used to present competitive placement.

(Malik, 2018)

6

It can help user engagement by injecting fun elements into an application to incentivize users to achieve goals. The Interaction Design Foundation states that certain needs must be fulfilled for the users for them to use an application without it feeling forced. These needs include:

- Autonomy – Users' actions must be voluntary.

- Relatedness – Users need to feel that the brand cares about what matters to them.

- Competence – Related to autonomy, this need is about keeping users comfortable as they discover your design by never feeling overwhelmed or confused (IDF, 2012).

Potentials

- Increase learner engagement and user satisfaction. Gamification can transform dull content into an interesting experience.

- Boost motivational support by giving users an incentive to keep engaging with gamified content.

- Shows visual progress and allows the user to see achievable goals over time, while also offering immediate feedback so that users perceive feelings of high individual performance (Blohm, 2013).

- Can be applied for most learning needs. By designing tasks of increasing difficulty, cognitive structures for the internalization of learning contents may be systematically created (Blohm, 2013).
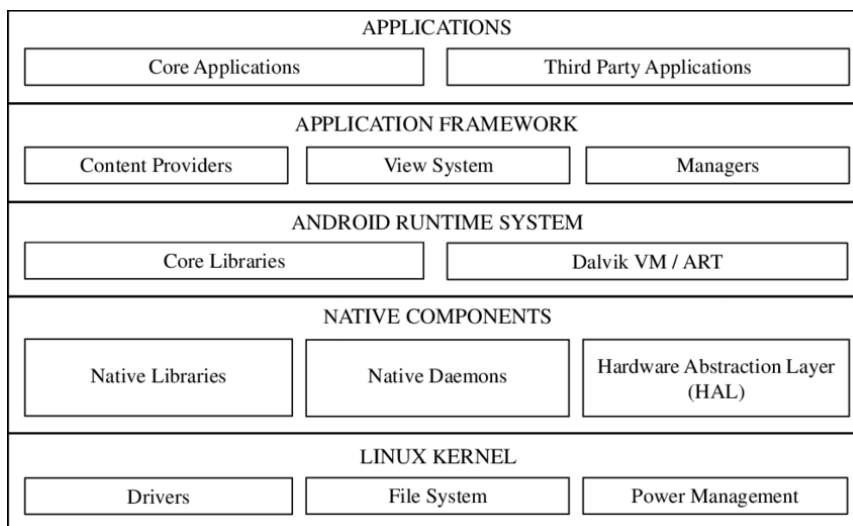
Platforms

Android

Overview

Android is an open source platform that is both an environment for software development and an operating system that runs on most smart devices. It is based on the Linux kernel, but modified to provide management of processes, memory, device-drivers, and the devices power. Originally a standalone company named Android Inc, Android is now developed by the Open Handset Alliance and is commercially sponsored by Google.

Android is a comprehensive platform, meaning it is a complete software stack for a mobile device. Android offers a unified approach to application development for mobile devices which means developers need only develop for Android, and their applications should be able to run on different devices powered by Android (www.tutorialspoint.com, 2020).

Android applications are generally developed in the Java language using the Android Software Development Kit, but Native apps can also be developed for Android devices.

Architecture

Android architecture consists of four layers: The Application, the Application Framework, the Android Runtime and Libraries, and the Linux Kernel.

APPLICATIONS	
Core Applications	Third Party Applications

APPLICATION FRAMEWORK		
Content Providers	View System	Managers

ANDROID RUNTIME SYSTEM	
Core Libraries	Dalvik VM / ART

NATIVE COMPONENTS		
Native Libraries	Native Daemons	Hardware Abstraction Layer (HAL)

LINUX KERNEL		
Drivers	File System	Power Management

(Meng, 2018)

8

iOS

Overview

iOS is a mobile operating system created by Apple Inc. that powers exclusively Apple mobile devices, including the iPhone, iPad, and iPod Touch. It is the world's second-most widely installed mobile operating system, after Android. iOS evolved from an earlier Apple operating system, Darwin, based on BSD UNIX (Bento, 2014). A new major version of iOS is released annually, usually to coincide with new devices. The current stable version is iOS 14.

Apple provides a Software Development Kit (SDK) that helps developers to create, install, run, and test native iOS Apps. XCode is the Integrated Development Environment (IDE) for Apple software development, provided by Apple. Applications are developed in Objective-C or Swift.

Objective-C is an object-oriented programming language that adds Smalltalk-style messaging to the C programming language (Sven, 2020). It is used on macOS to develop desktop applications and on iOS to develop mobile applications. Swift is the successor of Objective-C and can operate in conjunction with Objective-C.

Architecture

iOS, like Android, consists of four layers: The Core OS, the Core Services, the Media Layer, and Cocoa Touch.

(Intellipaat, 2020)

9

Technologies

React Native

Overview

React Native is an open-source framework used for creating native cross-platform applications for iOS and Android. It was developed by Facebook and is maintained by Facebook and a community of individual developers and companies. It uses JavaScript and JSX markup syntax. A native app can locate specific JavaScript code, which is later downloaded and compiled when the app is launched on an actual device, making React Native extremely efficient to develop with. React Native uses Node.js, a JavaScript runtime, to build your JavaScript code.

Features

React Native is efficient, declarative, and portable. Some features include:

- Reuse code across multiple platforms.

- Declarative views make code more predictable and easier to debug.

- React Native uses the same fundamental user interface building blocks as natively developed applications, but the building blocks are put together using JavaScript and React.

- Changes to JavaScript code can be live reloaded without rebuilding the native app (facebook, 2019).

Examples

Below is a sample piece of code showing the use of native components instead of web components.

```
1.  import React, { Component } from 'react';
2.  import { Text, View } from 'react-native';
3.
4.  class WhyReactNativeIsSoGreat extends Component {
5.    render() {
6.      return (
7.        <View>
8.          <Text>
9.            If you like React on the web, you'll like React Native.
10.         </Text>
11.         <Text>
12.           You just use native components like 'View' and 'Text',
13.           instead of web components like 'div' and 'span'.
14.         </Text>
15.       </View>
16.     );
17.   }
18. }
```

(Sample of React Native Code)

10

The following diagram shows a web/mobile application implementation utilizing the react core architecture to hold the state of the application, while the web and mobile application are in separate containers and components. The bridge translates all JavaScript code to the target device's native language.
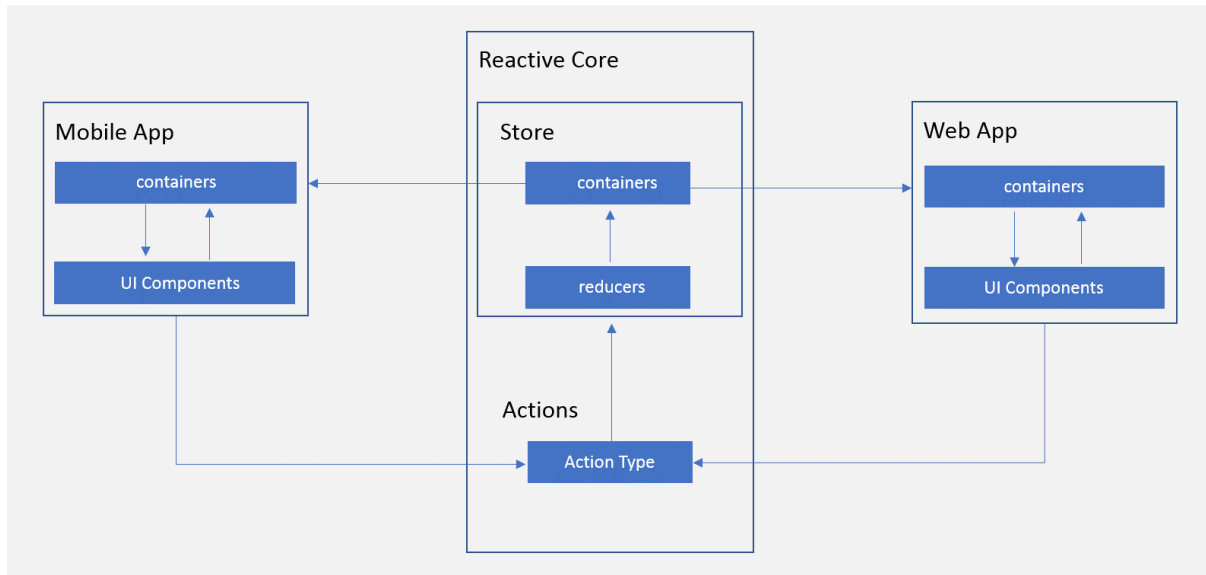
(Saiyed, 2018)

Node.js

Overview

Node.js is a JavaScript runtime designed to build scalable network applications. It uses an event-driven, non-blocking I/O model that makes it lightweight and efficient, perfect for data-intensive real-time applications that run across distributed devices (www.tutorialspoint.com, 2020).

Features

- Node was designed to optimize throughput and scalability in web applications.

- It is well-supported by many web hosting providers and is very portable, being available on Windows, macOS, Linux, Android, and iOS.

- The node package manager (NPM) provides access to thousands of reusable packages.

- It has a very active developer and third-party community.

- All APIs of Node.js library are asynchronous, meaning the server never waits for an API to return data. The node package manager (NPM) provides access to hundreds of thousands of reusable packages (www.tutorialspoint.com, 2020).

Example

Below is an example of a web server that is displaying "Hello World".

```
1   const http = require('http')
2
3   const hostname = '127.0.0.1'
4   const port = process.env.PORT
5
6   const server = http.createServer((req, res) => {
7     res.statusCode = 200
8     res.setHeader('Content-Type', 'text/plain')
9     res.end('Hello World!\n')
10  })
11
12  server.listen(port, hostname, () => {
13    console.log(`Server running at http://${hostname}:${port}/`
14  })
```

(Node.js, 2020)

The first line of code includes the http module, which has the createServer() method. The server is set to listen to the specified port and host name. When a new request is received, the request event is called, providing the request and response objects. The request object provides the request details, and the return object returns data to the caller. In the above example, request is not used but the return object will return content as an argument to end().

JavaScript

Overview

JavaScript is a cross-platform, object-oriented programming language that is dynamic and lightweight, most used as a part of web pages. It allows client-side script to interact with the user, which means the source code is processed by the client's web browser rather than on the web server. It is primarily used to enhance web pages to provide a more user-friendly experience including dynamically updating web pages, user interface enhancements such as menus and dialog boxes, and animations.

Features

- The capability to validate user input for errors.

- Provides greater control to the browser rather than being completely dependent on the web servers.

- Since browsers interpret JavaScript, it is platform independent.

- Capable in the detection of the user's browser and OS information.

Example

In the following example, JavaScript is used to add a button that when clicked, will display a pop-up box to enter a name for a new player in a game.

```
1   const para = document.querySelector('p');
2
3   para.addEventListener('click', updateName);
4
5   function updateName() {
6     let name = prompt('Enter a new name');
7     para.textContent = 'Player 1: ' + name;
8   }
```
(MDN, 2020)

Backend Technologies

Python

Overview

Python is an interpreted, object-oriented, high-level programming language with dynamic semantics (Python.org, 2020). It is an open source language, released under a GPL-compatible license, with its popularity increasing dramatically in recent years. There are currently two versions of Python being widely used, Python 2.7 and Python 3. As of January 1st, 2020, Python 2 is deprecated and is no longer supported by the Python Software Foundation. In December 2008, Python released version 3.0. This version was mainly released to fix problems which exist in Python 2. These changes make Python 3 backward incompatible. Some features of Python 3 were introduced to Python 2.x versions to make the migration process easy in Python 3.

Differences Between Python 2.7 and 3

Python 2.7	Python 3
• Many Python 2 Libraries are not forwards-compatible.	• Libraries are being created strictly for Python 3.
• Strings are stored as ASCII.	• Strings are stored as Unicode.
• In Python 2, the xrange() is used for iterations.	• The Range() function was introduced to perform iterations.
• Exceptions should be enclosed in notations.	• Exceptions should be enclosed in parenthesis.
• The value of the global variable will change while using it inside for-loop.	• The value of variables never changes.

Features

- It is an interpreter-based language, allowing one instruction at a time.

- Extensive data types.

- Variables can be strongly or dynamically typed.

- Supports automatic memory management (www.tutorialsteacher.com, 2020).

- Enhanced readability.

15

- For back-end web development, Python is not executed on the browser but executed on the server side.

Examples

```python
print('Hello, world!')
#This will work for Python 3 as it is enclosed in parenthesis.

Print 'Hello, world!'
#This will work for Python 2 as it is enclosed in notations.
```

(Difference Between Python 3 and 2.7)

```python
import flask

app = flask.Flask(__name__)
app.config["DEBUG"] = True


@app.route('/', methods=['GET'])
def home():
    return "<h1>Archive</h1>"

app.run()
```
(Smyth, 2018)

Above is an example of back-end development with Python 3 and Flask. This is an api file for a project.

16

Flask

Overview

Flask is a lightweight WSGI web application framework, designed to start an application quickly and easily, but scale in complexity. It began as a simple wrapper around Werkzeug and Jinja and has become one of the most popular Python web application frameworks (Pallets, 2020). It is a micro-framework, and so does not enforce any dependencies, but rather allows developers to choose their libraries and tools.

Features

- Lightweight and modular design, allowing for fewer extensions to be needed.

- Well-structured and comprehensive documentation.

- Built-in development server and quick debugger.

- Comes packaged with Jinja2, a web template engine that is designer friendly.

SQL

Overview

SQL (Structured Query Language) is used to communicate with a database and is the standard language for relational database management systems (www.sqlcourse.com, 2020). SQL is used to perform tasks such as updating or retrieving data from a database. It is in almost all tech stacks currently being used to deploy production grade applications (Rathee, 2020). Most relational databases support the basic SQL functionality written in the SQL documentation. On top of that, every database has its own set of additional features which call for additional SQL statements to utilise those features.

Features

- SQL allows duplicate rows/records/tuples in a table.

- A column/attribute can be unnamed in SQL.

- Columns/attributes in a table can share the same name.

- In the relational model, columns/attributes can be in any order. In SQL, the order of the columns/attributes is important.

- Null values are handled differently.

- Columnless tables are not acceptable in SQL.

- Updates to views can have different results than if the updates were made in the base table.

Examples

```
select "column1"
  [,"column2",etc]
  from "tablename"
  [where "condition"];
  [] = optional
```

(sqlcourse, 2020)

The above code shows an example of a select statement. This statement is used to query the database and retrieve selected data that match the criteria that you specify.

18

MySQL

Created in 1994, MySQL is one of the best-established RDBMSs (Relational Database Management System) and has evolved significantly since then. It works primarily on the relational database model.

Features

- Open source and widely compatible.

- Support for Memory storage engine for frequently used tables.

- Query Cache for repeatedly used statements.

- MySQL can run on various platforms UNIX, Linux, Windows and with many languages including PHP, PERL, C, C++, Java, etc.

- It handles a large subset of the functionality of the most expensive and powerful database packages.

- MySQL supports large databases, up to 50 million rows or more in a table.

Examples

```
1   CREATE TABLE shop (
2       article INT UNSIGNED  DEFAULT '0000' NOT NULL,
3       dealer  CHAR(20)      DEFAULT ''     NOT NULL,
4       price   DECIMAL(16,2) DEFAULT '0.00' NOT NULL,
5       PRIMARY KEY(article, dealer));
6   INSERT INTO shop VALUES
7       (1,'A',3.45),(1,'B',3.99),(2,'A',10.99),(3,'B',1.45),
8       (3,'C',1.69),(3,'D',1.25),(4,'D',19.95);
```

(Oracle, 2020)

Above is an example of the statements needed to for creating a table, assigning its variables and primary keys, and then inserting data into the new table.

```
1    SELECT * FROM shop ORDER BY article;
2    +---------+--------+-------+
3    | article | dealer | price |
4    +---------+--------+-------+
5    |       1 | A      |  3.45 |
6    |       1 | B      |  3.99 |
7    |       2 | A      | 10.99 |
8    |       3 | B      |  1.45 |
9    |       3 | C      |  1.69 |
10   |       3 | D      |  1.25 |
11   |       4 | D      | 19.95 |
12   +---------+--------+-------+
```

(Oracle, 2020)

Once the statements are executed, and a select all (the asterisk represents all)
statement is issued, the above table is displayed.

20

Firebase

Firebase is described as Backend-as-a-Service (BaaS), originally developed by Firebase in 2011 and acquired in 2014 by Google. The aim of Firebase is to supply all the Backend tools needed to quickly and securely develop high-quality apps for web and mobile. Firebase provides analytics, authentication, two kinds of database, cloud storage and more, and can be set up immediately if the developer possesses a Google account.

Each firebase project may be linked with multiple applications, for example, a mobile application and a web application may be set up with the same project and therefore have easy access to the same databases and cloud storage directories as each other.

Firebase's database service, Cloud Firestore, also provides "persistence", wherein data read from the database is cached and will still be available to the end-user when the device is offline. This can be extremely useful for applications which rely on reading from a cloud database.

Similar Applications

Duolingo

Overview

Duolingo is one of the most popular language-learning platforms, offering 98 courses in 38 different languages, and gaining approximately 300 million registered users (Wikipedia, 2019). It applies gamification into the application to engage and motivate users.

Features

- In Duolingo, Lingots are a reward for completing tasks that can be spent in the applications store. Lingots can be spent on items such as Power-Ups, or cosmetics.

- Leaderboards in Duolingo shows users how they are doing compared to their friends, and the community for the language they are learning.

- The level system to track users' daily activity and compete with their friends and the community. XP (experience point) also determines users language "level", which is displayed on their profile page.

- Duolingo uses badges as achievement tokens to show the skills a user has gained. They are displayed on user's profile and can make user feel invested in their study.

Screens

Each course in Duolingo is made up of separate modules, like this Spanish module.
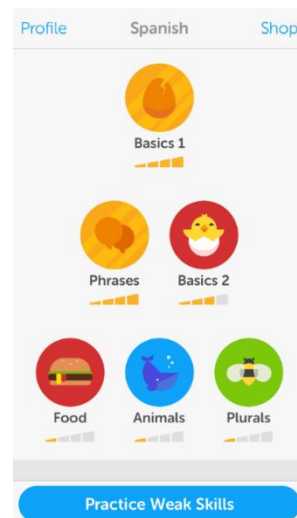
(Module Screen)

Each lesson in Duolingo is made up of multiple activities, such as translation or matching words.
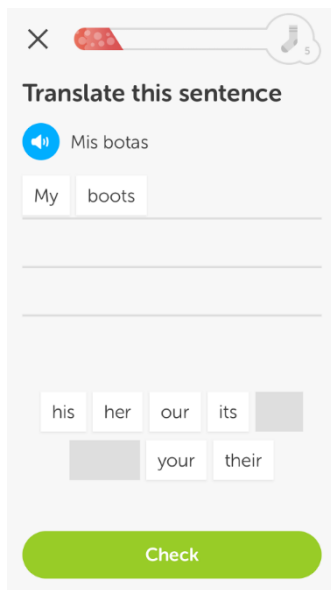
(Translation activity)

(Word Matching exercise)

Duolingo rewards users with feedback on their weakest vocabulary, giving positive feedback when a module is complete, a bar underneath each lesson that goes down the longer the user hasn't "strengthened" their skill, and tracks the users daily progress.
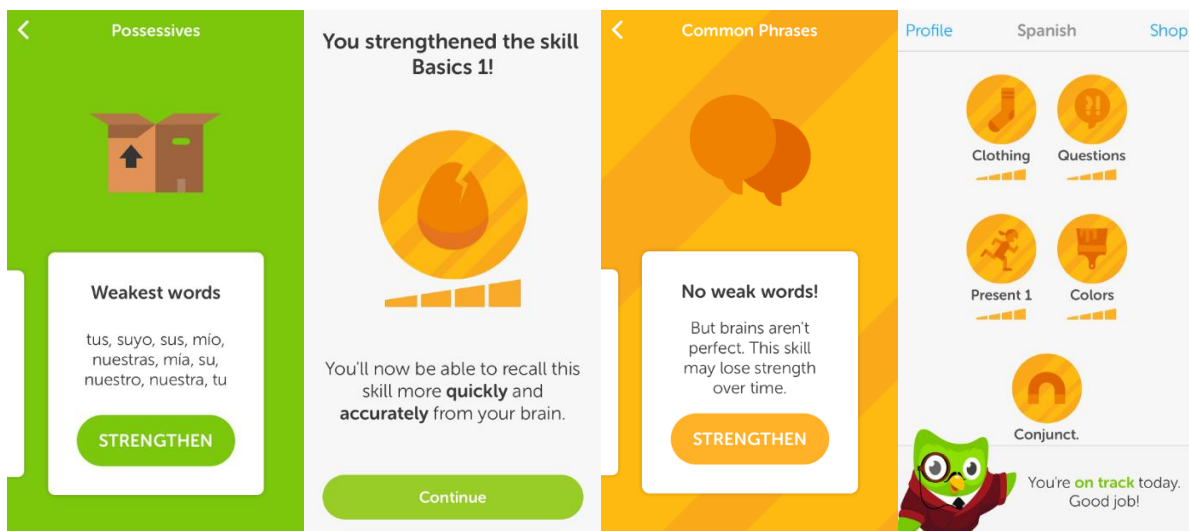
(Feedback on Weak Vocabulary   *(Positive Feedback)*   *(Strengthen a Lesson)*   *(Daily Tracker)*

Headspace

Overview

Headspace is a subscription-based Wellness App with 62 million downloads in 190 countries (Shieber, 2020). aimed to help users improve the quality of their life practicing simple meditation techniques.

Features

- Provides guided meditations to users via audio that come in a variety of themes, from beginner sessions to less-structured advanced sessions.

- Free introductory 10-day program with reminders.

- Clear and distinctive visual identity based around animated cartoon characters to explain concepts.

- Feedback is provided based on the user's timeline on the homepage, which charts packages, completed sessions and future sessions.

- Headspace counts how many days in a row the user actively used the app, and allows the user to unlock awards for regular, sustained usage.
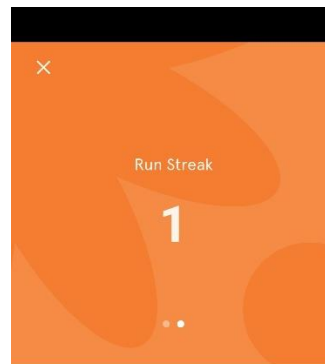
Screens

The app is split into multiple sections depending on what the user wants to target, and what meditation they want to do.

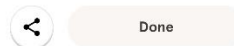*(Main Menu)*   *(Meditations based on issue)*   *(Meditations)*

24
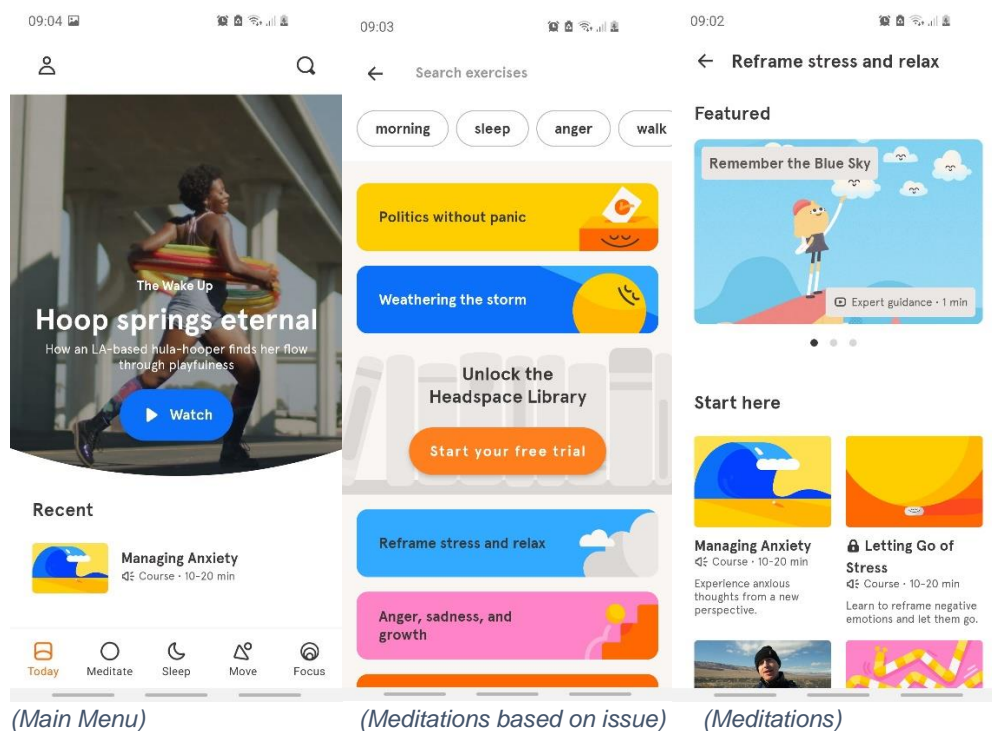
Meditations are a simple screen as it is primarily audio based. When a meditation is complete a screen is displayed showing the users streak, i.e. how many days they have used the app in a row.
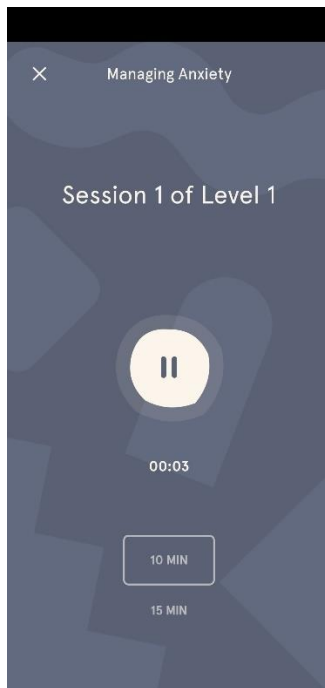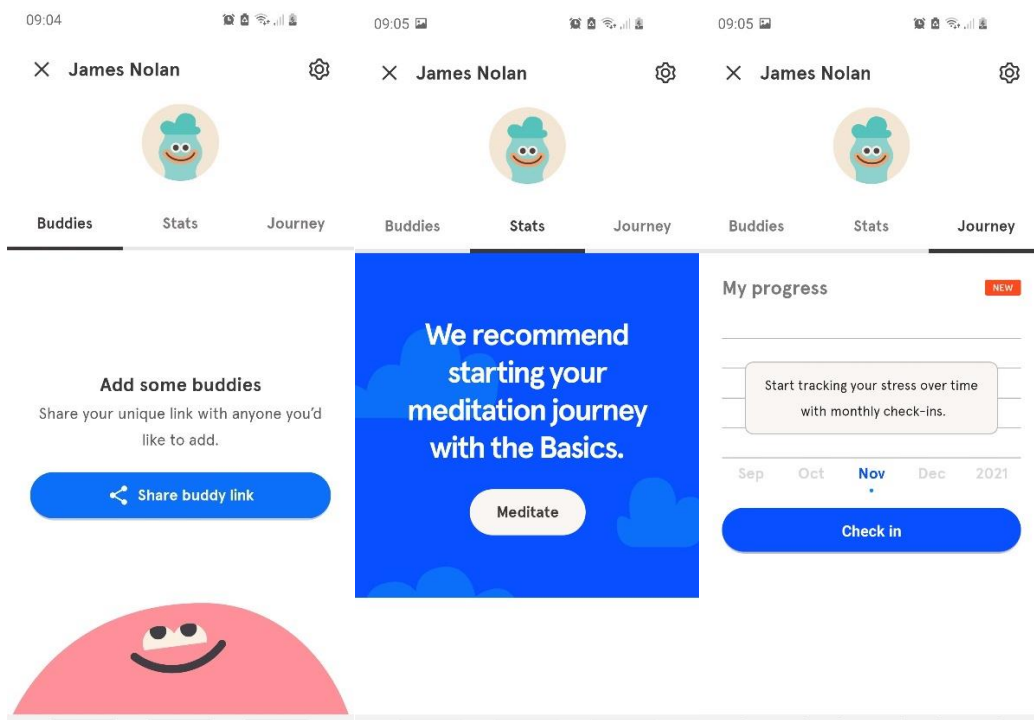

(Meditation taking place)

(Daily streak)

The user profile consists of a social tab, where users can see each other's progress, the user's statistics, and the users progress, which is tracking their stress over time.

(Social Tab)

(Statistics)

(Progress)

Find Me Gluten Free

Overview

Find Me Gluten Free is a gluten-free restaurant finder, aimed to allow the gluten-free community to crowdsource locations that have gluten-free options or are dedicated gluten-free.

Features

- Reviews on Find Me Gluten Free are from other members of the gluten-free community.

- The ability to find restaurants, fast food, bars, cafes, grocery stores and more.

- Search via current location or a specific address.

- View menus, call, or get directions for each business.

- View others' ratings and submit reviews.

Screens

The user can search from multiple different options such as Most Coeliac Friendly, Dedicated Gluten-Free, and Open Now. There is also a search feature that includes a map showing the nearest locations of restaurants.
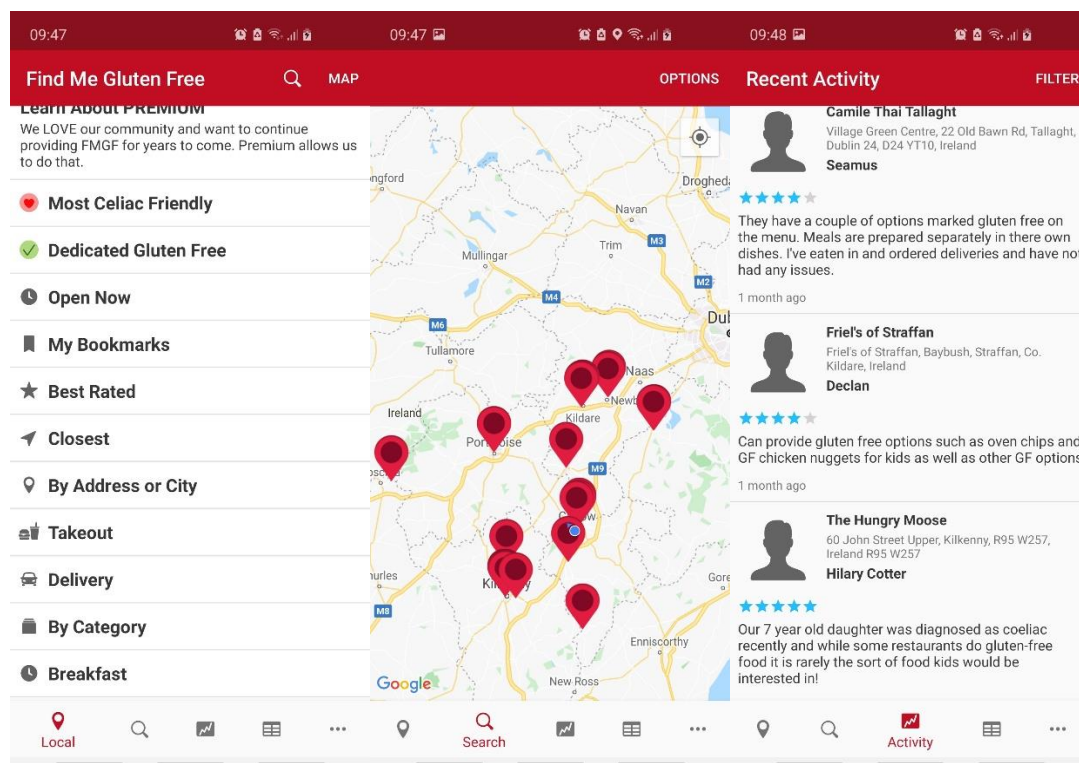
(Options for finding restaurant) *(Search feature including map)* *(Reviews)*

Conclusion

Coeliac Disease is an autoimmune disease that is triggered by gluten that is estimated to affect 1 in 100 people in Europe. It can result in multiple short-term effects such as fatigue, diarrhoea, vomiting. It can also cause long-term illnesses, such as osteoporosis and cancer, peripheral neuropathy, and ataxia. There is no cure for Coeliac Disease, but generally following a strict gluten-free can help manage symptoms. By creating an in-application quiz for people suffering from Coeliac Disease, it may help patients understand the dietary compliance that they must meet.

As the goal of this project is to help patients understand their dietary compliance needs, gamification, which is the application of game-based elements and game design techniques in non-game activities. will be used within this project. This is to increase learner engagement and provide better feedback immediately to the patient.

The application building technologies that are needed for this project were provided by Erasmus+. React Native was chosen as the application framework for the development of the application as it can be used for creating native cross-platform applications. Node.js was chosen as the runtime environment as the frontend will be using JavaScript. As I have not worked with React Native or Node.js before, it has given me an opportunity to learn these tools. The backend for the project will be using Flask and Python, as well as Firebase.

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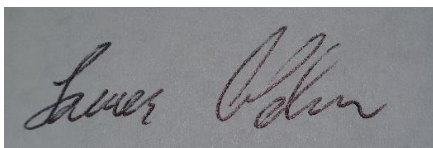
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31

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